What Drives Large Scale Battery Storage Value in California?

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Energy Storage Association

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Overview

- Battery description
- Customer profile
- Value Drivers
- Value vs. Cost
- Payback vs. changes in assumptions
- Conclusions

Battery Description

- Innogy Technology Limited $25 million sodium bromine battery
  - 12 MW output
  - $2,083/kw
  - $320/kw annual fixed capital cost*
  - 65% efficient
  - 10 hours storage with 14 hour charge time
- Battery can also operate at a higher peak capacity and lower efficiency which lowers the installed cost/kw

* Assumes a 5O/50 capital structure, 12% ROE, 40% tax rate and 15 year life and 15.4% capital recovery factor

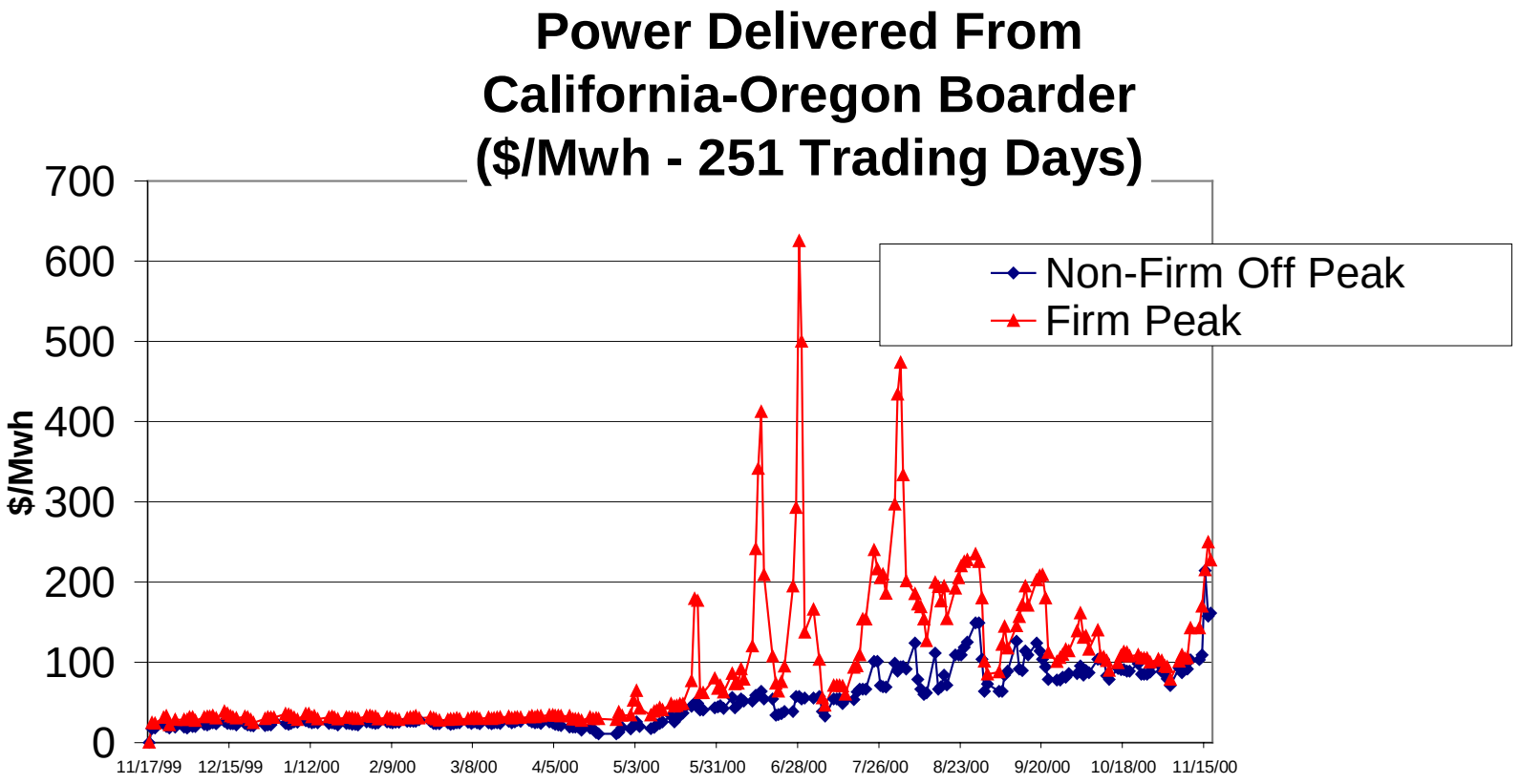
Customer Profile

- 12 MW battery storage service provided to PG&E commercial customers seeking lower energy and T&D rates assuming
  - 45% load factor
  - Customers pay commercial E-20 tariff for T&D
  - Customers face market based energy rates
  - Customers willing to pay a premium for increased reliability and power quality

Value Drivers

1) Peak-to-off peak energy price difference
   - Charge battery at a low off-peak price to avoid high on-peak price
   - Potential ancillary service value (not quantified)
2) T&D capacity charge reduction
   - Avoid high, peak monthly demand charges by purchasing electricity off-peak for use on-peak
3) Quality and reliability premium
   - Function of consumer willingness to pay a premium for greater reliability and power quality

Peak-to-off peak energy price difference



Source: Bloomberg 251 trading days - excluding weekends

Peak-to-off peak energy price difference

- Benefit based on:
  - Peak vs. off-peak energy price difference
  - 65% battery efficiency (e.g. 35% more power purchased off-peak than is used on peak)
- During the year ending November 2000, simulated net energy price "arbitrage" benefits were $64/kw*
- *This benefit will be cyclical - depending on market tightness and degree of price cap regulation*

*Assuming benefits accrue 10 hours/day x 250 business days

T&D Capacity Charge Reduction

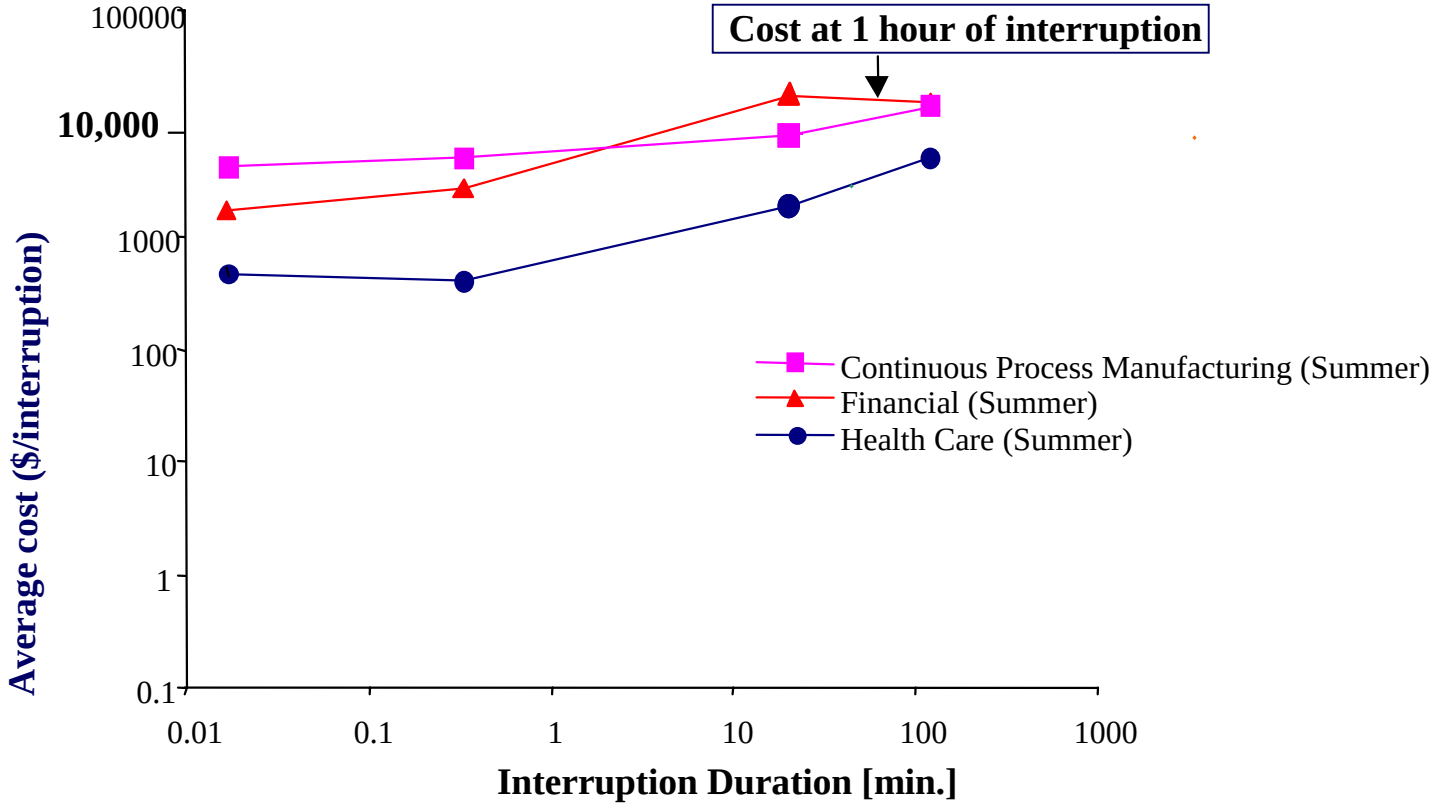
- Benefit depends on the difference between PG&E peak and off-peak commercial E-20 T&D rates
  - Peak rate: 5.70 cents/kwh (demand charge + volumetric)
  - Off-peak rate: about 1.0 cent/kwh
  - Assume 35% efficiency loss and 3% T&D loss
- In 2000, simulated T&D benefits were $103/kw*
- *This benefit has low risk given that T&D rates are not likely to change significantly*

*Assuming benefits accrue 10 hours/day x 250 business days

Quality & Reliability Premium

- Function of consumer willingness to pay
- Varies based on cost of outage
- Varies based on quality & reliability of grid based power
- Can increase to as high as $10,000/hour

Quality & Reliability Premium



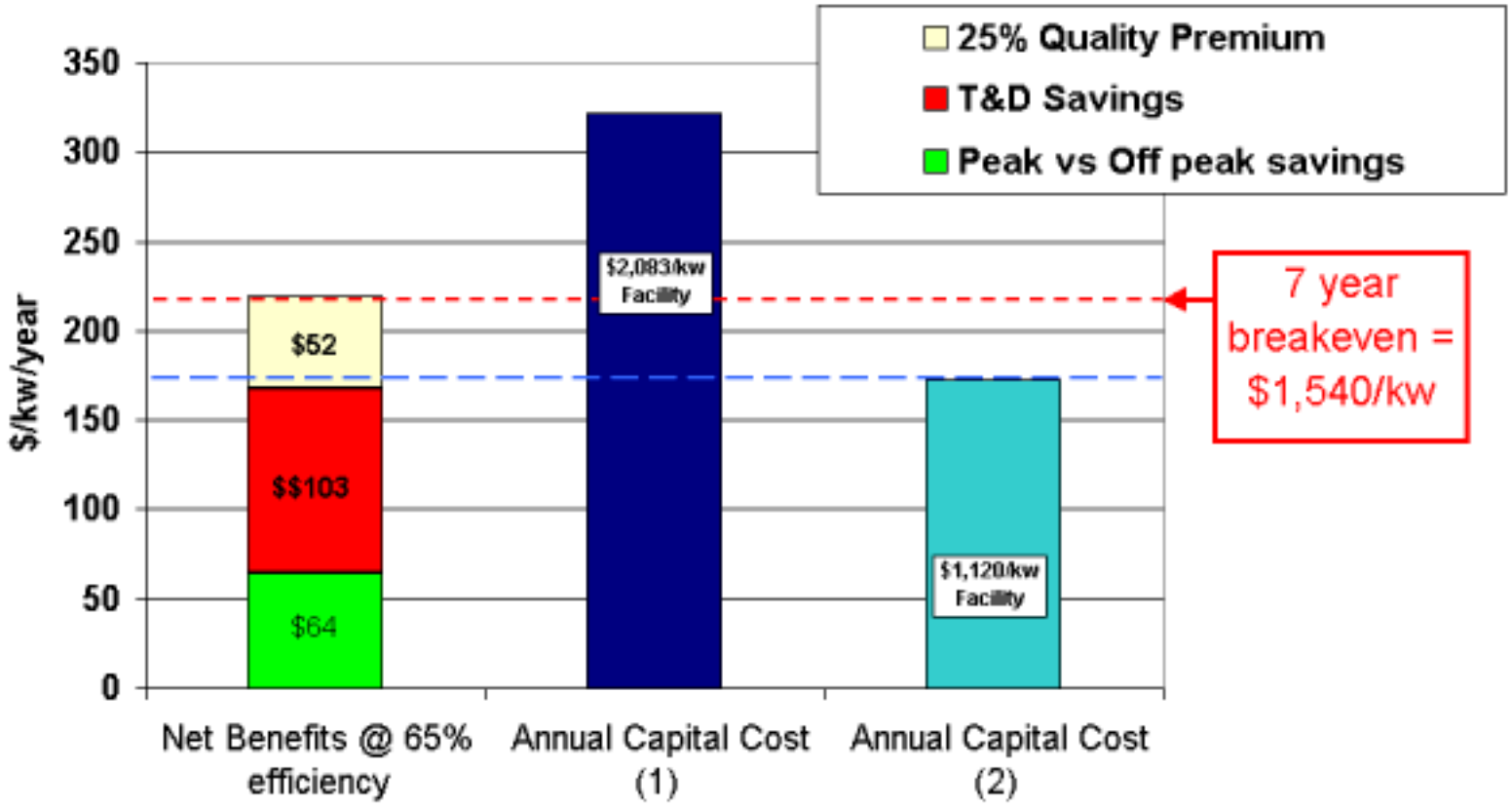
Source: E-Source, "Reliability in the Emerging Electricity Marketplace: The End-User Perspective." Results Workshop for Sponsors, Chicago, IL, February 4, 1999. Revised March 8, 1999. (Restricted availability.)

Quality & Reliability Premium

- Estimated annual premium: $52/kw* assuming
  - Premium is paid for 10 on-peak hours
  - Consumer is willing to pay 25% premium relative to the average US commercial electricity price
- *This benefit is customer specific and will vary depending on the reliability and quality of grid based power*

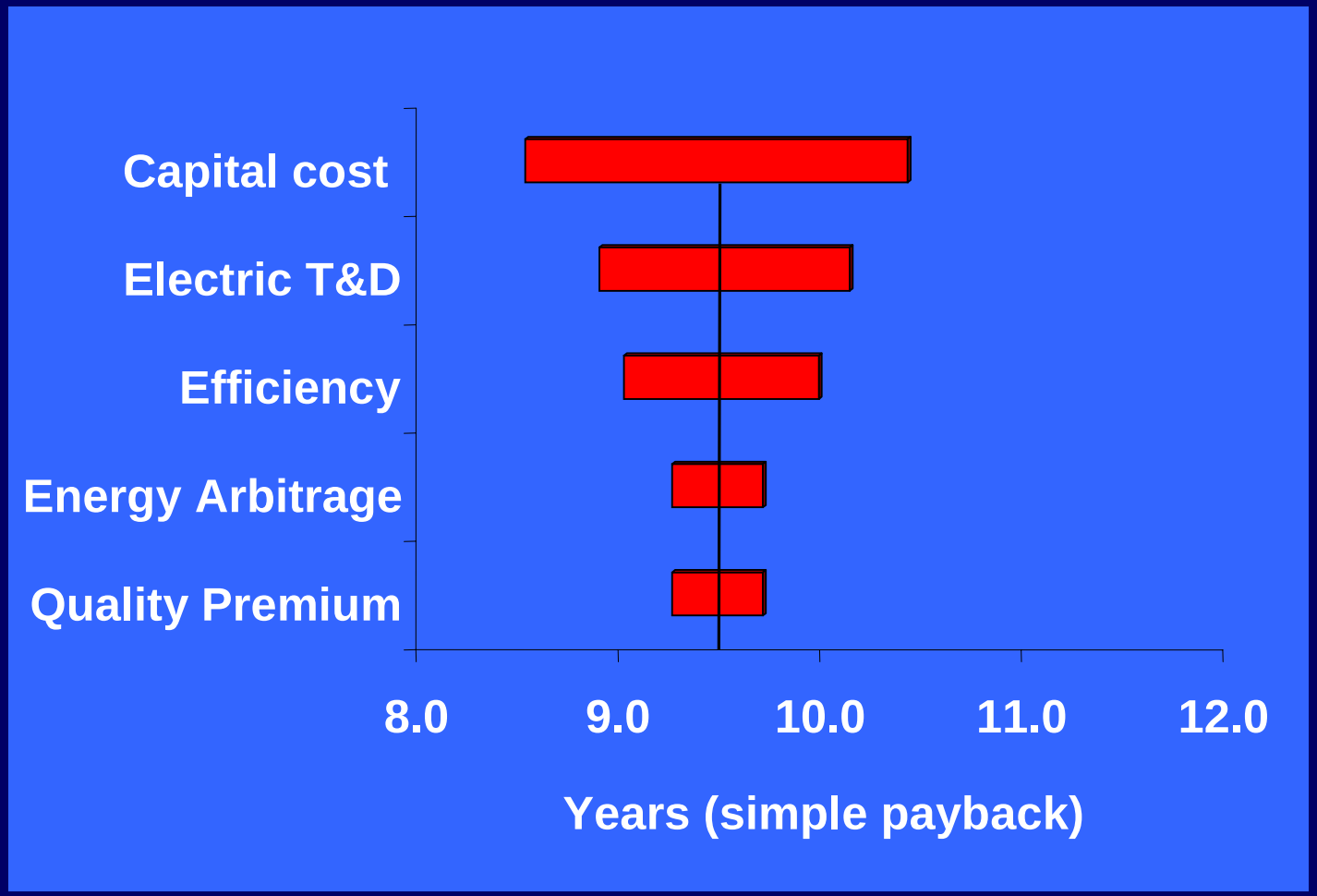
*Assuming premium paid 10 hours/day x 250 business days

Value vs. Cost



(1) Assuming $2,083/kw cost and 15.4% LCCF.
(2) Assuming projected $1,120/kw cost and 15.4% LCCF.

Payback vs. Changes In Assumptions



Conclusions

- Storage battery economics are driven by:
  - Peak to off-peak energy price differences which are cyclical
  - Peak to off-peak T&D rate differences which are likely to be stable
  - Consumer willingness to pay a quality premium
    - *Varies by customer type as well as reliability and quality of grid based power*
- At current cost, the battery is not economic but would breakeven at $1,540/kw